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ANNUAL VARIATION OF AIRBORNE POLLEN IN THE CITY OF VINKOVCI, NORTHEASTERN CROATIA

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Abstract: Pollen concentration in the atmosphere of Vinkovci (northeastern Croatia) has been analyzed using a Hirst-type volumetric spore trap. During the year 2005, 58 pollen types were recorded with the sum of annual totals of 14,011. The pollen spectrum reflected the floristic diversity of the region. Non-arboreal pollen predominantly contributed to the total pollen sum with a percentage of 81.80%. The main pollen producers characterized by allergenic pollen were: *Betula*, *Quercus*, *Fraxinus*, *Populus*, *Pinus*, Urticaceae, *Ambrosia*, Poaceae, *Plantago* and *Artemisia*. Urticaceae was the most frequent and most abundant pollen type accounting for 46.58% of the total annual pollen, followed by *Ambrosia* (19.66%) and Poaceae (11.01%).

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INTRODUCTION

It is estimated that the prevalence of allergic diseases has been steadily increasing in the Republic of Croatia. Knowledge of the variation of airborne pollen grains throughout the year is therefore an important fact for the prevention and treatment of allergies caused by pollen. In this context, information about the presence of different pollen types and their concentrations could be very useful for physicians in order to enable better management of seasonal allergic symptoms [10].

Airborne pollen sampling was carried out in several Croatian cities by employing volumetric sampling [11, 21]. However, this is the first study conducted in Vinkovci. The objective of this investigation was to identify the overall pollen types, and more particularly, the allergenic pollen content in the investigated area, and then to explore their seasonal variations.

MATERIALS AND METHODS

The city of Vinkovci is situated in the northeastern part of the Republic of Croatia, in the fertile plains between the Danube and the Sava rivers. Vinkovci and its surroundings is located at an altitude of 78-125 m above sea level and characterized by arable lands and famous oak and ash forests. The climate is temperate-continental with favourable rain distribution throughout the year.

A Burkard 7-day volumetric trap was placed on the roof near the centre of the city, a height of about 15 m. The air was sucked in a flow rate of 10 litres per minute. Pollen grains were impacted onto Melinex tapes which were coated with a thin film of liquid silicone. A tape was replaced each Monday morning and cut into segments corresponding to 24-hour periods. For slide mounting, glycerin jelly was used. Pollen grains were observed and counted on the surface of 4 horizontal bands. Pollen concentration was expressed as the daily average of pollen grains per cubic meter of air.

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Table 1. Annual totals of average daily pollen counts and their allergenic potential.

	Annual total	Percent	Allergenic potential[a]
Arboreal Plants (AP)			
Quercus sp.	685	4.89	**
Betula sp.	491	3.50	**
Fraxinus sp.	328	2.34	**
Populus sp.	284	2.03	**
Pinus sp.	222	1.59	*
Corylus sp.	129	0.92	**
Juglans sp.	80	0.57	**
Sambucus sp.	57	0.41	–
Cupressus sp.	55	0.39	**
Alnus sp.	37	0.27	**
Tilia sp.	37	0.27	*
Rosaceae	35	0.25	*
Salix sp.	33	0.23	*
Aesculus sp.	27	0.19	*
Carpinus sp.	16	0.10	**,*
Fagus sp.	16	0.02	*
Platanus sp.	4	0.03	**
Juniperus sp.	4	0.01	**
Forsythia sp.	2	0.01	*
Ulmus sp.	1	0.00	**
Picea sp.	1	0.00	*
Larix sp.	1	0.00	*
Ligustrum sp.	1	0.00	*
Castanea sp.	1	0.00	**,*
Humulus sp.	1	0.00	-
Clematis sp.	1	0.00	*
Hedera sp.	1	0.00	*
Total	2,550	18.19	

	Annual total	Percent	Allergenic potential[a]
Non-arboreal plants (NAP)			
Urticaceae	6,526	46.58	**,*
Ambrosia sp.	2,738	19.66	***
Poaceae	1,543	11.01	***,**,*
Plantago sp.	232	1.65	***,*
Artemisia sp.	205	1.46	***
Chenopodiaceae/ Amaranthaceae	38	0.30	**,*
Rumex sp.	34	0.24	***
Senecio sp.	25	0.18	*
Lotus sp.	22	0.16	–
Asteraceae	20	0.14	–
Euphuorbia sp.	15	0.11	–
Aster sp.	14	0.09	*
Anthriscus sp.	9	0.06	*
Thalictrium sp.	9	0.06	*
Carex sp.	6	0.04	*
Filipendula sp.	3	0.02	*
Endymion sp.	3	0.02	–
Primula sp.	3	0.02	*
Papaveraceae	2	0.01	–
Sinapis sp.	2	0.01	–
Melandrium sp.	2	0.01	–
Heracleum sp.	1	0.00	–
Caryophyllaceae	1	0.00	–
Typha sp.	1	0.00	–
Galium sp.	1	0.00	–
Centaurea sp.	1	0.00	*
Ranunculus sp.	1	0.00	*
Potentilla sp.	1	0.00	*
Solidago sp.	1	0.00	*
Cichorium sp.	1	0.00	–
Taraxacum sp.	1	0.00	*
Total	11,461	81.80	
Total (AP +NAP)	14,011	100.00	

[a] According to Grant Smith 1990; *** – high; ** – medium; * – low.

Pollen was identified with the help of specific bibliography [4, 6, 9] and the palynological collection of the Aerobiology Laboratory, Faculty of Agriculture in Osijek. The allergenic potential of important types is indicated according to Grant Smith [4].

RESULTS

A total of 58 pollen taxa, of these 27 taxa arboreal and 31 non-arboreal, were identified during 2005 (Tab. 1). The pollen spectrum reflected the floristic diversity of the investigated region and the majority of the sources of airborne pollen are present in local and regional flora. Some of them are used for ornamental purposes and do not represents the local flora such as *Pinus*, *Cupressus*, Rosaceae, *Aesculus*, *Juniperus*, *Forsithya*, *Picea*, *Larix*, etc.

A total pollen concentration (TP) of 14,011 grains/m^3 was identified during the study period. Non-arboreal pollen (NAP) predominantly contributed to the total pollen sum with a percentage of 81.80% followed by arboreal (AP) 18.9%.

Seasonal variation in AP and NAP during the 1-year period is presented in Figure 1. The major pollen concentration period could be established from May – August with the dominance of NAP. The highest monthly pollen concentration was observed in August (3,827 grains) followed by May (3,285 grains) and June (2,286 grains). The richness of the pollen types varied throughout the investigated period and the maximum number of pollen types was registered in June (29 types), followed by May and July (23 types), and the minimum recorded in October (5 types). Types representing arboreal pollen were registered from the beginning of the monitoring (March) to July and reached the highest values during April and May. NAP pollen starts with a minor concentration in April and then dominated in the pollen spectrum in the air throughout the year.

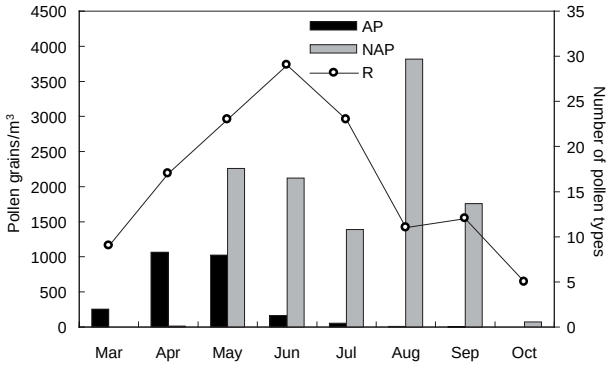

Figure 1. Total monthly arboreal pollen (AP) and non-arboreal pollen (NAP) concentration and pollen richness (R) as a number of pollen types.

Table 2. Selected values of 10 taxa dominated in Vinkovci, 2005.

Taxon	Period of occurence	Duration (days)	Concentration in a peak day (grains m^{-3})	Peak day
Populus	19.03.-22.04.	34	76	09.04.
Fraxinus	27.03.-02.06.	68	28	30.04.
Betula	05.04.-01.06.	53	77	09.04.
Quercus	09.04.-03.06.	55	65	02.05.
Urticaceae	26.04.-05.10.	162	352	04.05.
Poaceae	01.05.-07.10.	160	105	28.05.
Pinus	03.05.-07.06.	35	25	24.05.
Plantago	18.05.-30.09.	135	11	02.08.
Ambrosia	16.07.-09.10.	85	326	30.08.
Artemisia	20.07.-07.10.	69	30	03.08.

Ten taxa recorded concentrations of up to 1% of TP and accounted for 94.63% of TP (Tab. 1, Tab. 2, Fig. 2). The main pollen producers were arboreal plants such as *Betula*, *Quercus*, *Fraxinus*, *Populus* and *Pinus*, and accounted for 14.4% of the total pollen grains. Among herbaceous plants, Urticaceae, *Ambrosia*, Poacceae, *Plantago* and *Artemisia* were found frequently in the atmosphere making up to 80.36% of the total (Tab. 1). All of the dominant pollen types could be involved in allergenic pollinosis (Tab. 1). Quantitative trends of these main pollen types (period of occurrence, duration, concentration in a peak day and peak day) are given in Table 2 and shown in Figure 2.

Among them, *Populus* pollen season was registered as an earlier one, starting pollination in the second half of March. *Populus* showed a short pollen period (34 days) during which it reached a high pollen concentration (76 grains m^{-3} on a peak day) in the first decade of April.

The beginning of the *Fraxinus* pollen season was registered soon after *Populus*. It has a twice as long duration of pollination (68 days) but with significantly lower concentration on a peak day (28 grains m^{-3}).

The *Betula* pollen appeared in the air at the beginning of April, and termination of the pollination was noticed on the beginning of June. The peak with 77 grains m^{-3} was registered soon after the start of pollination.

Quercus represents the dominant arboreal pollen type in the air with the annual total of 685 grains. Pollen release continued from mid-April until the beginning of June. However, the highest counts were recorded surprisingly at the end of its pollination.

The Urticaceae pollen season was characterized from the third decade of April until the first decade of October and had the longest duration (162 days) with the concentration of 352 grains m^{-3} on the peak day. Urticaceae represents the most abundant pollen type with the annual total of 6,526 grains.

Pollen grains of Poaceae were recorded during the 160th day of the year, from May – October. The peak was at the end of May reaching the value of 105 grains m^{-3}.

The length of *Pinus* pollen season was relatively short. It started pollinating at the beginning of May and ended at the beginning of June. Concentration was not high with the maximum values of 25 grains m^{-3}.

Plantago was another pollen type with a long pollen period, from the second decade of May until the end of September. However, it was recorded throughout the season with a relatively low pollen concentration, with the peak of only 11 grains m^{-3}, registered at the beginning of August.

Ambrosia started with pollination in mid-July and terminated in the first decade of October. The highest value was noticed at the end of August, having the peak value of 326 grains m^{-3}.

Pollen grains of *Artemisia* were registered in the air from the third decade of July to the first decade of October. It has a similar pollination period to *Ambrosia*, but with significantly lower pollen counts. Maximum value (30 grains m^{-3}) was counted at the beginning of August.

DISCUSSION

Pollen spectrum (58 taxa) in the atmosphere of Vinkovci is mostly specific for the region and belongs to arboreal species (27) and non-arboreal species (31). Non-arboreal pollen was dominant in the air of the investigated region reflecting the agricultural background of the territory. The prevalence of herbaceous pollen has also been reported in some other agricultural regions [5]. Besides native flora the pollen spectrum includes several plants used for ornamental purposes, as has been similarly reported in some other region [8, 16, 17] . These similarities could be explained by the fact that more or less many of exotic tree species are cultivated for ornamental purposes in most cities throughout the world.

The major pollen concentration period was noticed during the summer months (May – August) and the greatest varieties of pollen types were observed in June. This could be explained by with the overlapping of the end pollination periods of many arboreal plants and the start of pollination periods of the non-arboreal species. Termination of the pollen season is the same as seen in reports from other Central European countries [20, 23].

Airborne pollen of allergenic plants dominated in the air throughout the year.

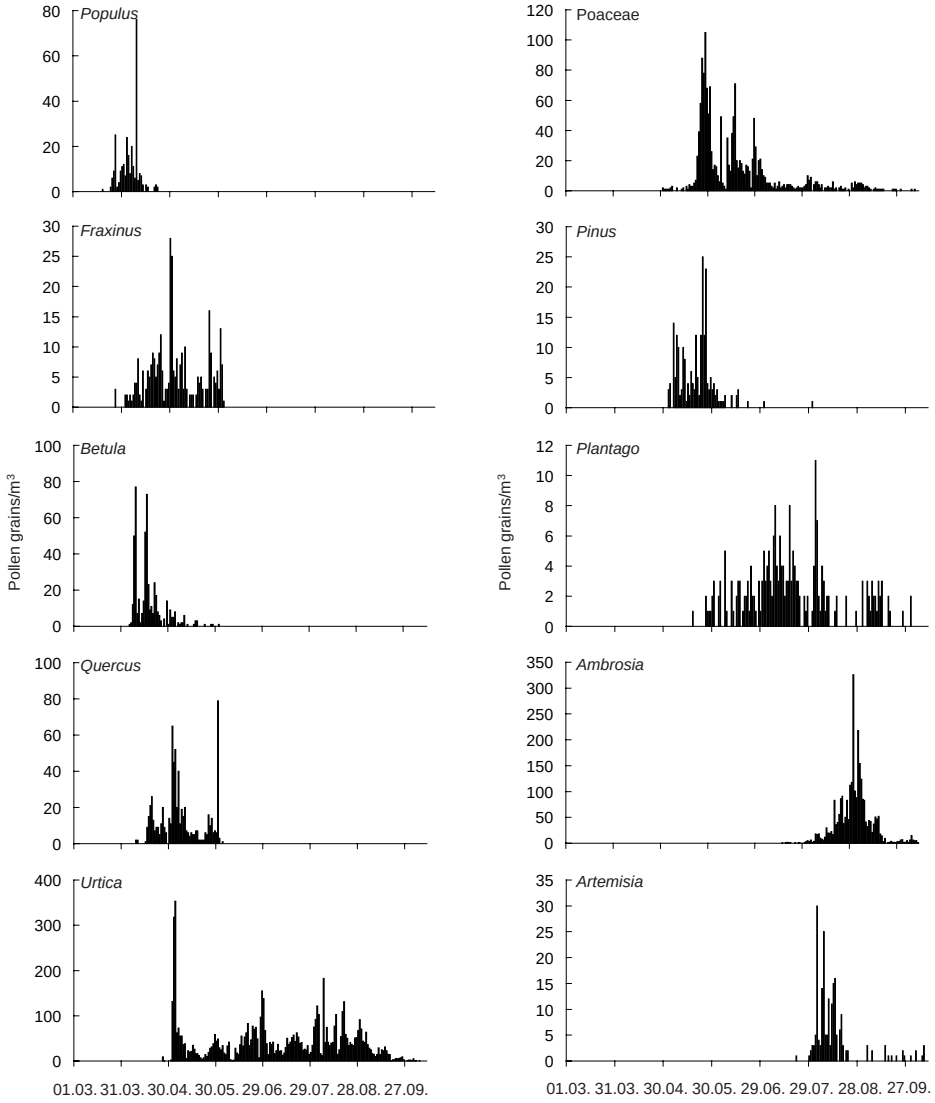

Figure 2. Seasonal variation for 10 allergenic taxa in Vinkovci, 2005. Note the different scales.

Most of the dominant pollen types identified in this study were placed on the list of the most important plants causing pollinosis in Europe [18]. However, there are significant differences in the number and quality of pollen grains in the air of particular European regions.

Although *Betula*, *Fraxinus* and *Populus* are anemophilous species well known for the production of large amounts of airborne pollen in many parts of Europe [12, 15, 22], in our investigation they were present in lower values compared to herbaceous pollen. Perhaps the existence of a cyclic biorhythm in their reproduction reflected on the low pollen counts during the investigated year [1, 3]. *Quercus* pollen reached the highest annual total of pollen among arboreal plants, caused by the nearby presence of oak forests in Vinkovci surroundings.

The dominant pollen type during the investigation period belongs to the genus *Urtica*, a very common ruderal weed in this region, particularly abundant in nitrified areas such as roadsides and between cultivated areas. Allergy to pollen of *Urtica* is diagnosed only very infrequently [19]. Other most significant pollen types found in the air are common ragweed and Poaceae. These are very abundant weed species in the region and, moreover, are known as very potent aeroallergens [2]. They are a common cause of pollynosis in the temperate zone [7, 13, 14].

CONCLUSIONS

1. Pollen grains of 58 taxa were identified during the investigated period in Vinkovci and surroundings (northeastern Croatia). Among them, 27 taxa were arboreal and 31 non-arboreal. Non-arboreal pollen predominantly contributed to the total pollen sum with a percentage of 81.80%, followed by arboreal with 18 and 19%.

2. Ten of them (*Betula*, *Quercus*, *Fraxinus*, *Populus*, *Pinus*, Urticaceae, *Ambrosia*, Poaceae, *Plantago* and *Artemisia*)

formed 94.3% of spectrum, and all of them are considered allergenic.

3. Urticaceae was the most frequent and most abundant pollen type accounting for 46.58% of the total annual pollen, followed by *Ambrosia* (19.66%) and Poaceae (11.01%).

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